

What is claimed is:

1. A method of sol-gel processing using an inorganic metal salt and a mixed solvent system, comprising:

preparing a solution including an inorganic metal salt, water, and an organic solvent having a metal salt concentration and a ratio of organic solvent to water; and

incubating the solution at a temperature for a period of time;

wherein the metal salt concentration, ratio of organic solvent to water, temperature, and time are selected to provide a sol or a gel having desired characteristics.

2. The method of claim 1, wherein the step of preparing the solution comprises:

providing an aqueous solution of an inorganic metal salt;

providing an organic solvent; and

mixing the inorganic metal salt solution and the organic solvent in proportions so that the metal salt concentration and the ratio of organic solvent to water are achieved.

3. The method of claim 1, further comprising the step of neutralizing the solution after the incubation.

4. The method of claim 1, further comprising the step of adding a dispersant to the solution.

5. The method of claim 4, wherein the dispersant is added prior to the incubation.

6. The method of claim 4, wherein the dispersant is added after the incubation.

7. The method of claim 1, wherein the inorganic metal salt contains a metal selected from the group consisting of aluminum, hafnium, silicon, zirconium, titanium, lanthanum, germanium, tantalum, and combinations thereof.

8. The method of claim 1, wherein the organic solvent is selected from the group consisting of methanol, ethanol, isopropanol, n-propanol, tert butyl alcohol, n-butanol, acetone, and glycerol.

9. The method of claim 1, wherein the concentration of inorganic metal salt ranges from about 0.005 M to about 0.5 M

10. The method of claim 9, wherein the concentration of inorganic metal salt ranges from about 0.025 M to about 0.2M.

11. The method of claim 1, wherein the ratio of organic solvent to water ranges from about 0.1/1 to 10/1.

12. The method of claim 11, wherein the ratio of organic solvent to water ranges from about 0.5/1 to about 5/1.

13. The method of claim 1, wherein the temperature ranges from about 20 °C to about 150 °C.

14. The method of claim 13, wherein the temperature ranges from about 22 °C to about 120°C.

15. The method of claim 1, wherein the time ranges from about one minute to about 72 hours.

16. The method of claim 1, wherein a sol is produced.
17. The method of claim 1, wherein the ratio of organic solvent to water ranges from about 0.1/1 to 2/1 and a gel is produced.
18. The method of claim 1, wherein monodispersed particles are produced.
19. The method of claim 1 wherein the temperature ranges from about 20 °C to about 25 °C and wherein nanosize particles are produced.
20. The method of claim 1 wherein the temperature ranges from about 20 °C to about 25 °C and wherein monodispersed particles are produced.
21. The method of claim 4, wherein the concentration of dispersant ranges from above zero to about 10^{-2} g/cm³.
22. A method of producing nanosize particles using an inorganic metal salt and a mixed solvent system, comprising:
preparing a solution including an inorganic metal salt, water, and an organic solvent having a metal salt concentration and a ratio of organic solvent to water; and
incubating the mixture at a temperature for a period of time;
wherein the metal salt concentration, ratio of organic solvent to water, temperature, and time have been manipulated to provide particles having a diameter of about 10 nm to about 100 nm.
23. The method of claim 22, further comprising the step of neutralizing the solution after the incubation.

24. The method of claim 22, further comprising the step of adding a dispersant to the solution.

25. The method of claim 22, wherein the inorganic metal salt contains a metal selected from the group consisting of aluminum, hafnium, silicon, zirconium, titanium, lanthanum, germanium, tantalum, and combinations thereof.

26. The method of claim 22, wherein the organic solvent is selected from the group consisting of methanol, ethanol, isopropanol, n-propanol, tert butyl alcohol, n-butanol, acetone, and glycerol.

27. The method of claim 22, wherein the concentration of inorganic metal salt ranges from about 0.005 M to about 0.5 M

28. The method of claim 27, wherein the concentration of inorganic metal salt ranges from about 0.005 M to about 0.05 M

29. The method of claim 22, wherein the ratio of organic solvent to water ranges from about 0.1/1 to 10/1

30. The method of claim 29, wherein the ratio of organic solvent to water ranges from about 2/1 to about 10/1.

31. The method of claim 22, wherein the temperature ranges from about 20 °C to about 150 °C.

32. The method of claim 31, wherein the temperature ranges from about 22 °C to about 120 °C.

33. The method of claim 22, wherein the time ranges from about one minute to about 72 hours.

34. A method of producing a sol from an inorganic metal salt at room temperature comprising:

preparing a solution including an inorganic metal salt, water, and an organic solvent having a metal salt concentration and a ratio of organic solvent to water; and

incubating the solution at room temperature for a period of time;

wherein the metal salt concentration, ratio of organic solvent to water, and time are selected to provide a sol having desired characteristics.

35. The method of claim 34, further comprising the step of neutralizing the solution after the incubation.

36. The method of claim 34, further comprising the step of adding a dispersant to the solution.

37. The method of claim 34, wherein the inorganic metal salt contains a metal selected from the group consisting of aluminum, hafnium, silicon, zirconium, titanium, lanthanum, germanium, tantalum, and combinations thereof.

38. The method of claim 34, wherein the organic solvent is selected from the group consisting of methanol, ethanol, isopropanol, n-propanol, tert butyl alcohol, n-butanol, acetone, and glycerol.

39. The method of claim 34, wherein the concentration of inorganic metal salt ranges from about 0.005 M to about 0.5 M

40. The method of claim 34, wherein the ratio of organic solvent to water ranges from about 0.1/1 to 10/1

41. The method of claim 34, wherein the temperature ranges from about 20 °C to about 25 °C.

42. The method of claim 34, further comprising drying the sol to produce a particle powder.

43. A method of producing monodisperse particles at room temperature, comprising:

preparing a solution including an inorganic metal salt, water, and an organic solvent having a metal salt concentration and a ratio of organic solvent to water;

incubating the solution at room temperature for a period of time;

wherein the metal salt concentration, ratio of organic solvent to water, and time are selected to provide a sol having desired characteristics; and

drying the sol to produce a powder of monodisperse particles.

44. The method of claim 43, further comprising the step of neutralizing the solution after the incubation.

45. The method of claim 43, further comprising the step of adding a dispersant to the solution.

46. The method of claim 43, wherein the inorganic metal salt contains a metal selected from the group consisting of aluminum, hafnium, silicon, zirconium, titanium, lanthanum, germanium, tantalum, and combinations thereof.

47. The method of claim 43, wherein the organic solvent is selected from the group consisting of methanol, ethanol, isopropanol, n-propanol, tert butyl alcohol, n-butanol, acetone, and glycerol.

48. The method of claim 43, wherein the concentration of inorganic metal salt ranges from about 0.005 M to about 0.5 M.

49. The method of claim 43, wherein the ratio of organic solvent to water ranges from about 0.1/1 to 10/1.

50. The method of claim 49, wherein the ratio of organic solvent to water ranges from about 4/1 to 10/1.

51. The method of claim 43, wherein the temperature ranges from about 20 °C to about 25 °C.

52. A sol produced according to the method of claim 1.

53. A gel produced according to the method of claim 1.

54. A sol produced according to the method of claim 34.

55. An ultrafine or nanosize particle powder produced according to the method of claim 43.

56. A material produced from the sol of claim 52.

57. A material produced from the sol of claim 54.

58. A material produced from the powder of claim 55.

59. A material produced from the gel of claim 53.